

# Prevalence of Healthy Behaviors among Cancer Survivors in the United States: How Far Have We Come?

Hannah Arem<sup>1,2</sup>, Scherezade K. Mama<sup>3</sup>, Xuejing Duan<sup>4</sup>, Julia H. Rowland<sup>5</sup>, Keith M. Bellizzi<sup>6</sup>, and Diane K. Ehlers<sup>7</sup>



## ABSTRACT

**Background:** The 16.9 million cancer survivors in the United States are at increased risk for comorbidities and recurrence. However, this risk may be attenuated by a healthy lifestyle. This study describes health behaviors by cancer history to inform behavior change priorities.

**Methods:** We analyzed 2013–2017 data from the National Health Interview Survey. There were 164,692 adults, of whom 12,648 reported a cancer history. We calculated prevalence of smoking, physical activity, alcohol consumption, body mass index (BMI), and sleep duration by cancer history, age, and cancer site. We conducted logistic regression to determine odds of meeting lifestyle recommendations by cancer history.

**Results:** Overall, those with a cancer history were less likely to report current smoking (14.1% vs. 16.8%) and moderate/heavy drinking (18.8% vs. 21.9%) than those without a cancer history.

However, a lower percentage of cancer survivors met physical activity guidelines (14.2% vs. 21.1%) or reported a healthy BMI (31.6% vs. 34.7%) compared with those without a cancer history. Cancer survivors were more likely to report excessive sleep (6.8% vs. 3.6%). In adjusted logistic regression, survivors were more likely to meet recommendations on smoking, physical activity, and BMI but were less likely to meet alcohol recommendations; meeting sleep recommendations did not differ by cancer history.

**Conclusions:** While cancer survivors had lower prevalence of smoking and moderate/heavy drinking, they also had lower prevalence of physical activity and healthy BMI, and reported longer sleep duration. Regression analyses suggested survivors only showed poorer behaviors for alcohol.

**Impact:** Targeted health promotion interventions among cancer survivors are needed.

## Introduction

The number of cancer survivors in the United States is 16.9 million at present and is expected to reach 21.7 million by 2029 (1, 2). An estimated 67% of cancer survivors are surviving 5 or more years after diagnosis (1). These survivors are at increased risk for cancer recurrence and second primary cancers, as well as many physical (e.g., peripheral neuropathy, insomnia, and pain) and psychosocial symptoms (e.g., depression and emotional distress), among other treatment side effects that adversely impact quality of life (2, 3).

Over the past few decades research on health behaviors among cancer survivors has grown significantly (4, 5). One recent mortality study suggested that modifiable lifestyle behaviors could prevent 48% of cancer-related deaths among women and 44% in men (6). The growing body of evidence on the benefits of a healthy lifestyle has also led the National Comprehensive Cancer Network (NCCN; ref. 7), American Society of Clinical Oncology (8–10), and the American Cancer Society (ACS; ref. 11) to publish and promote

guidelines recommending smoking cessation, limiting alcohol consumption, increasing physical activity, and maintaining a healthy body weight to mitigate the detrimental effects of treatment and lower cancer recurrence and mortality. These lifestyle recommendations are supported by multiple expert reports on specific behaviors and cancer risk and survivorship (12, 13). In addition, NCCN encourages screening for treatment side effects (e.g., fatigue and insomnia) and providing cancer survivors with lifestyle recommendations (14). While not explicitly a recommendation at present, sleep is an emerging area of research related to cancer risk and survivorship, as impaired sleep is a common side effect of cancer diagnosis and treatment, and can have significant health consequences (15–17).

Cancer diagnosis is often promoted as a “teachable moment,” where behavior change might be motivated by a desire to combat risk of recurrence or other complications (18). However, before promoting specific behavior change it is necessary to better understand the prevalence of health behaviors among cancer survivors. Previous studies using the Behavioral Risk Factor Surveillance System (BRFSS) nationally representative data from 2009 (19), ACS’s 2008 study of Cancer Survivors II (20), and the National Health Interview Survey (NHIS) dataset from 1998–2001 (21) suggest that a significant percentage of cancer survivors do not meet guidelines on smoking (8%–17%), physical activity (53%–71%), alcohol consumption (16.3%), or maintaining a healthy body mass index (BMI, 60%). Over the past two decades there have been shifts in both policy (e.g., additional taxes on cigarettes, smoke and tobacco-free policies, etc.; ref. 22) and research funding (e.g., increases in lifestyle intervention research for cancer survivors; ref. 23) that we hypothesize should impact these health behaviors. We thus set out to update nationally representative figures on prevalence of select health behaviors to understand whether we have made progress since the benchmark 2005 NHIS article (21), updating relevant lifestyle recommendations and adding analyses

<sup>1</sup>GW Milken Institute School of Public Health, Department of Epidemiology, Washington D.C. <sup>2</sup>GW Cancer Center, Washington D.C. <sup>3</sup>Department of Kinesiology, College of Health and Human Development, The Pennsylvania State University, University Park, Pennsylvania. <sup>4</sup>GW Milken Institute School of Public Health, Department of Biostatistics, Washington D.C. <sup>5</sup>Smith Center for Healing and the Arts, Washington D.C. <sup>6</sup>Human Development and Family Sciences, University of Connecticut, Storrs, Connecticut. <sup>7</sup>University of Nebraska Medical Center, Omaha, Nebraska.

**Corresponding Author:** Hannah Arem, George Washington University, Milken Institute School of Public Health, 950 New Hampshire Avenue NW, 5th Floor, Washington D.C. 20052. Phone: 202-994-4676; Fax: 202-994-0082; E-mail: hannaharem@gwu.edu

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for sleep. We (i) analyzed prevalence of meeting guidelines for smoking, alcohol consumption, physical activity, BMI, and sleep duration overall and by cancer site and age, and (ii) conducted logistic regression to understand odds of meeting these recommendations by cancer history.

## Materials and Methods

The NHIS is a continuous cross-sectional household interview survey that uses a probability design to generate a representative sampling of U.S. households and noninstitutionalized adults. Interviewers are employed and trained by the U.S. Census Bureau staff using procedures outlined by the National Center for Health Statistics. Among households selected for survey, one sample adult aged 18 years or older completes the interview. We combined datasets from 2013 to 2017. From 2006 to 2015, the NHIS design included oversampling of African American, Hispanic, and Asian individuals. The sampling plan changed in 2016 to account for changes in distribution of the U.S. population; the new sampling plan eliminated oversampling of race/ethnicity groups at the household level, except among those aged 65 or older. Detailed information on questionnaires and methods are available online from the National Center for Health Statistics (24). We used the Sample Adult File, which collects information on demographic characteristics, health history, and lifestyle behaviors. The final response rate for the Sample Adult File was 61.2% for 2013, 58.9% for 2014, 55.2% for 2015, 54.3% for 2016, and 53.0% for 2017.

### Participants

There were 164,692 adults in our combined sample. Cancer was self-reported from the question "Have you ever been told by a doctor or health professional that you had cancer or a malignancy of any kind?" Those who responded yes specified what kind of cancer and were given opportunities to report first, second, third, or more cancer sites, leading to identification of 16,514 cases. Individuals who reported only non-melanoma skin cancer ( $n = 2,706$ ) or skin cancer unknown type ( $n = 1,092$ ) were excluded from analyses. Individuals whose response to the question about cancer history were coded as refused, not ascertained, or do not know ( $n = 71$ ) were also excluded from the analyses. Some individuals reported unknown skin cancer and another cancer type and thus were kept in the dataset as a primary case of the other cancer type. These exclusions were not mutually exclusive (e.g., individuals could have fallen into multiple categories). In the combined dataset from 2013 to 2017 we thus included 12,648 individuals with a self-reported history of cancer and 147,971 individuals with no reported cancer history.

### Measures

We categorized demographic and health information as follows: age at questionnaire (18–<40, 40–<65, and 65+ years), sex (male or female), race/ethnicity (non-Hispanic white, non-Hispanic black, and Hispanic, other), education (< high school, high school graduate, some college, and Bachelor's degree or greater), family income (<\$20,000, \$20,000–\$45,000, and ≥\$45,000), health insurance coverage over prior 12 months (yes or no), functional limitations (limited in any way or not limited), and self-reported health status (excellent, very good, good, fair, and poor). We created categories for missing responses. Age at first cancer diagnosis was used for those who reported multiple cancers. Time since diagnosis in years was calculated by subtracting reported age at diagnosis from age at interview. However, some individuals reported years since diagnosis rather than age at diagnosis (e.g., reported breast cancer diagnosis at

age 1). Therefore, for cancer sites where <5% of diagnoses are among individuals under age 20 (using 2012–2016 Surveillance, Epidemiology, and End Results data) we assumed that the age at diagnosis was incorrectly reported as time since cancer diagnosis ( $n = 452$ ).

## Health behaviors

### Smoking

We categorized participants into groups of never (<100 lifetime cigarettes), former, or current smokers. Current smokers were further categorized by smoking frequency (every day or some days). In logistic regression, we collapsed categories into nonsmoker (meeting guidelines) versus current smoker.

### Alcohol consumption

NHIS collates self-reported alcohol consumption as: "lifetime abstainer," "former," "current infrequent," "current light," "current moderate," and "current heavy" based on whether and when an individual drank, and how much (25). There is a robust body of literature documenting associations between alcohol intake and risk of breast, liver, colon, and rectal cancer, and some head and neck cancers (11, 26, 27). Some evidence suggests that even 5–14.9 grams alcohol per day (<1 drink) is associated with an elevated cancer risk among women (28) and the International Agency for Research on Cancer (IARC) has classified alcohol as a carcinogen. Professional societies such as ACS suggest that women consume no more than one drink/day and that men consume no more than 2 drinks/day. Only limited research exists on risks of alcohol consumption among cancer survivors. Given the differences in these recommendations in relation to cancer risk and to allow readers to see more detailed categories, we included all the NHIS-collated categories in our prevalence estimates. We combined the moderate and heavy groups to assign the high-risk behavior in regression analyses, as both ACS and IARC consider these groups high risk, while there is still more controversy around risks of light drinking. We also did not select former drinkers as the referent group due to the possibility of reverse causation (i.e., individuals may stop drinking due to poor health) and never drinkers may have other differences in characteristics that were not captured in our data. We categorized meeting guidelines as those who did not report moderate/heavy drinking.

### Physical activity

Participants reported weekly frequency and duration of moderate- and vigorous-intensity activities. We calculated total weekly physical activity by adding weekly minutes of moderate-intensity activities in bouts ≥10 minutes to 2× the minutes of vigorous-intensity activities in bouts ≥10 minutes, as during data collection questions were phrased using a minimum of 10-minute bouts to reflect common practice for defining moderate- to vigorous-intensity activity during the time of data collection (2013–2017; ref. 29). We categorized participants according to the 2008 U.S. Physical Activity Guidelines (ref. 29; also recommended for cancer survivors; ref. 30) as inactive (0 min/week), insufficiently active (>0 but <150 min/week), or sufficiently active (150+ min/week). Strength-based physical activity was categorized into <2 times/week (does not meet recommendations) or 2+ times/week (meets recommendations). We then created a composite for meets both aerobic and strength guidelines, meets aerobic only, meets strength only, insufficient activity for either aerobic and strength, and inactive (neither strength nor aerobic). Meeting guidelines was the group who reported sufficient aerobic and strength exercise.

## BMI

BMI was calculated in  $\text{kg}/\text{m}^2$  using self-reported height and weight. We categorized BMI into the following categories: 15–<18.5, 18.5–<25, 25–<30, 30–<35, and 35+  $\text{kg}/\text{m}^2$ . We then further categorized individuals into maintained a normal body weight (18.5–<25), overweight (25–<30), or obese (30+  $\text{kg}/\text{m}^2$ ). Those with a BMI <15 or >60 were categorized as missing. Those with a BMI of 18.5–<25 were categorized as meeting guidelines.

## Sleep

Participants reported hours of sleep in a 24-hour period (30 minutes–24 hours). We categorized daily hours of sleep as <5, 5–<7, 7–8, >8–9, or 9+ based on previous literature showing increased risks of mortality at either end of a U-shaped curve. National Sleep Foundation guidelines in 2015 recommended 7–9 hours of sleep for adults age 18–64 and 7–8 hours of sleep for adults age 65+ (31). We thus categorized individuals into meeting these guidelines or not by age group.

## Data analysis

NHIS data are collected using a complex sample design involving stratification, clustering, and multi-stage sampling (32). Person-level weights are adjusted according to a quarterly post-stratification by age/sex/race/ethnicity classes based on population estimates produced by the U.S. Census Bureau to provide national estimates. All reported *N*s are unweighted and percentages are weighted. The R package “survey” was used to account for complex survey procedures. Weights were divided by five to account for combining 5 years of data. Since the 5 years of data fell into different sample design periods (design periods 2013–2015 and 2016–2017), as instructed by NHIS data analysis guidelines, we modified the stratum variable for the sample period of 2016–2017 by adding multiples of 1,000 before combining with the 2013–2015 strata (33). We used descriptive statistics and  $\chi^2$  tests to compare sample characteristics and behaviors by cancer history. We also generated prevalence estimates by cancer site to better determine the public health burden among specific groups. We used logistic regression to examine odds of meeting guidelines, creating three models: model 1 adjusted for variables deemed important *a priori*, model 2 adjusted for additional **Table 1** variables that were significantly associated with cancer history, and model 3 mutually adjusting for other lifestyle recommendations. Results of fully adjusted model 3 are presented in the text. As the previous NHIS study showed differences in health behaviors by age, we set out *a priori* to look at differences in selected behaviors by age. Thus, we conducted logistic regression analyses stratified by age category and tested for multiplicative interaction. To compare our prevalence rates with previously published NHIS prevalence rates, we used a *Z*-test on the basis of published weighted prevalence and SEs. R (Version 3.6.0) was used to conduct descriptive statistics,  $\chi^2$  tests, and regression models. Python (Pandas, Python 3) was used for data management.

## Results

### Population

Cancer survivors were on average 65.6 years old (SD, 14.4), compared with 48.1 years old (SD, 18.0) among those with no cancer history. In **Table 1** we reported that compared with those with no cancer history, cancer survivors were more likely to be female (61% vs. 54%), non-Hispanic white (82% vs. 66%), report functional limitations (67% vs. 35%), and were less likely to report excellent health status (12% vs. 28%; all *P* < 0.001). **Table 2** shows distribution by sex and

cancer type. Among women with a cancer history, 41% reported breast cancer; 12% reported cervical cancer; 7% reported colon cancer; 10% reported uterine cancer; 9% reported melanoma; 5% reported ovarian cancer; 5% reported cancers of the larynx, lung, or pharynx; 5% reported leukemia or lymphoma; and 6% reported other cancers. Among men with a cancer history, 46% reported prostate cancer; 12% colon cancer; 15% melanoma; 9% cancers of the larynx, lung, or pharynx; 9% leukemia or lymphoma; and 9% other cancers. Average years since diagnosis varied among women [range: 6.6 years (larynx, lung, and pharynx) to 19.1 years (cervix)] and men [range: 7.3 years (larynx, lung, and pharynx) to 10 years (leukemia/lymphoma)].

## Prevalence estimates

### Smoking

Compared with individuals without a cancer history overall, a lower percentage of those with a cancer history were never smokers (48% vs. 62%) or current smokers (14% vs. 17%; **Table 3**). Still, among those ages 18–<40, 29% with a cancer history reported current smoking compared with 18% of those without a cancer history.

### Alcohol

Moderate alcohol drinking was reported by 14% of those with a cancer history versus 16% among those without a cancer history, and heavy drinking was reported by 5.1% and 5.6%, respectively. By age group, a lower percentage of those age 18–<40 with a history of cancer reported heavy drinking compared with those without a history of cancer, although among survivors age 65+ a higher percentage reported moderate or heavy drinking compared with those with no cancer history.

### Physical activity

Only 24% of those with a cancer history met the aerobic physical activity guidelines compared with 28% of those with no cancer history; among those with a history of cancer, 39% reported no physical activity at all, which was higher than those without a cancer history (31.2%). Only 14% of those with a cancer history met physical activity guidelines for aerobic and strength-based exercise (compared with 21% of those without a cancer history), with a declining percentage of cancer survivors meeting guidelines as age increased (22% among those age 18–<40 and 12% among those age 65+).

### BMI

Overweight or obesity was reported by 66.3% of cancer survivors, compared with 63.6% of those with no cancer history. The greatest differences by cancer history were observed for those who were obese class 2: among survivors age 18–<40, there was 16.1% compared with 10.7% among those with no cancer history.

### Sleep

We found similar percentages of individuals reporting <5 hours of sleep per night (4% among those with a cancer history and 3% among those with no cancer history). However, among individuals age 18–<40, 7.9% of those with a history of cancer reported <5 hours of sleep per night compared with 2.5% of those without a cancer history. For long sleep duration, 7% of those with a cancer history reported >9 hours/day compared with 4% of those without a cancer history.

We also examined differences in prevalence of meeting lifestyle recommendations by cancer site (**Table 4**). Lung/larynx/pharynx and gynecologic cancer survivors had the highest percentages of individuals reporting current smoking (18.6% and 26.2%,

**Table 1.** Demographic and health characteristics of the adult population in the NHIS by cancer history (2013–2017).<sup>a, b</sup>

Characteristic	History of cancer					No history of cancer					P <sup>c</sup>
	Total n	Total	Age in years			Total n	Total	Age in years			
			18–<40	40–<65	≥65			18–<40	40–<65	≥65	
N	12,648		810	4,425	7,413	147,971		54,739	62,079	31,153	
		% (SE)	% (SE)	% (SE)	% (SE)		% (SE)	% (SE)	% (SE)	% (SE)	
Sex											<0.001
Male	4,918	39.0 (0.5)	26.9 (2.0)	34.5 (0.8)	43.0 (0.7)	67,058	46.4 (0.2)	47.9 (0.3)	48.3 (0.3)	39.5 (0.3)	
Female	7,730	61.0 (0.5)	73.1 (2.0)	65.5 (0.8)	57.0 (0.7)	80,913	53.6 (0.2)	52.1 (0.3)	51.7 (0.3)	60.5 (0.3)	
Race/ethnicity											<0.001
White, non-Hispanic	10,120	82.2 (0.5)	72.8 (1.9)	80.1 (0.7)	84.4 (0.6)	93,153	66.4 (0.4)	59.9 (0.5)	68.1 (0.4)	75.6 (0.5)	
Black, non-Hispanic	1,202	8.5 (0.3)	9.7 (1.4)	9.2 (0.5)	8.0 (0.4)	20,344	13.2 (0.2)	14.4 (0.3)	13.4 (0.3)	10.8 (0.3)	
Hispanic	878	6.2 (0.3)	13.6 (1.3)	7.3 (0.5)	4.8 (0.3)	23,655	14.0 (0.3)	18.2 (0.4)	12.6 (0.3)	8.8 (0.3)	
Non-Hispanic, other	448	3.1 (0.2)	3.9 (0.7)	3.5 (0.4)	2.8 (0.2)	10,819	6.3 (0.1)	7.6 (0.2)	6.0 (0.2)	4.8 (0.2)	
Education											<0.001
<High school	1,788	13.3 (0.4)	11.9 (1.3)	10.4 (0.5)	15.2 (0.5)	20,297	12.3 (0.2)	10.0 (0.2)	11.5 (0.2)	18.5 (0.3)	
High school graduate	5,767	44.8 (0.5)	48.2 (2.2)	42.8 (0.9)	45.6 (0.7)	66,272	44.3 (0.3)	46.3 (0.4)	41.6 (0.3)	45.8 (0.4)	
2- or 4-year college graduate	3,556	29.2 (0.5)	32.6 (2.0)	34.2 (0.9)	25.7 (0.6)	44,738	31.5 (0.2)	33.5 (0.3)	33.3 (0.3)	23.7 (0.3)	
Bachelor's degree	1,488	12.3 (0.4)	7.1 (1.1)	12.3 (0.6)	12.9 (0.5)	16,051	11.5 (0.2)	9.9 (0.2)	13.1 (0.2)	11.3 (0.3)	
Family income											<0.001
≥\$45,000	1,515	12.8 (0.4)	20.2 (1.9)	26.0 (0.8)	3.9 (0.3)	30,996	22.4 (0.2)	21.6 (0.3)	31.6 (0.3)	5.1 (0.2)	
\$20,000–<\$45,000	1,176	8.9 (0.3)	20.3 (1.6)	15.5 (0.6)	3.6 (0.3)	28,533	19.0 (0.1)	25.0 (0.3)	20.4 (0.2)	4.6 (0.1)	
<\$20,000	1,186	8.9 (0.3)	25.2 (1.9)	11.4 (0.5)	5.7 (0.3)	23,566	15.4 (0.2)	24.0 (0.3)	11.5 (0.2)	7.0 (0.2)	
Functional limitations											<0.001
Limited in any way	8,573	67.2 (0.6)	43.0 (2.2)	61.9 (0.9)	73.1 (0.7)	53,844	35.4 (0.2)	16.7 (0.2)	38.8 (0.3)	64.4 (0.4)	
Not limited	4,033	32.4 (0.6)	56.5 (2.2)	37.9 (0.9)	26.5 (0.7)	94,017	64.5 (0.2)	83.3 (0.2)	61.2 (0.3)	35.5 (0.4)	
Health insurance coverage											<0.001
Covered	11,856	94.0 (0.3)	76.3 (1.9)	88.5 (0.6)	99.3 (0.1)	122,191	83.6 (0.2)	76.1 (0.3)	83.4 (0.2)	98.2 (0.1)	
Not covered	301	2.2 (0.2)	8.0 (1.1)	4.2 (0.4)	0.4 (0.1)	6,944	4.6 (0.1)	6.9 (0.1)	4.3 (0.1)	0.9 (0.1)	
Reported health status											<0.001
Excellent	1,492	12.3 (0.4)	18.9 (1.8)	12.8 (0.6)	11.2 (0.5)	40,185	28.1 (0.2)	38.6 (0.3)	24.0 (0.2)	16.6 (0.3)	
Very good	3,295	26.4 (0.5)	28.1 (2.1)	24.7 (0.8)	27.3 (0.6)	48,279	33.1 (0.2)	34.7 (0.3)	32.6 (0.3)	31.0 (0.3)	
Good	4,214	33.2 (0.5)	28.6 (1.9)	31.3 (0.9)	34.9 (0.6)	39,584	26.1 (0.2)	21.1 (0.2)	28.0 (0.2)	32.1 (0.3)	
Fair	2,600	20.0 (0.4)	17.7 (1.7)	21.1 (0.7)	19.5 (0.6)	15,425	9.9 (0.1)	4.9 (0.1)	11.6 (0.2)	15.8 (0.3)	
Poor	1,038	8.1 (0.3)	6.7 (1.0)	10.1 (0.5)	7.0 (0.3)	4,448	2.8 (0.1)	0.7 (0.0)	3.9 (0.1)	4.6 (0.1)	

<sup>a</sup>All reported Ns are unweighted and % are weighted.

<sup>b</sup>Percentages may not add up to 100 due to rounding or missing data.

<sup>c</sup>P values are comparing the total columns by cancer history.

respectively). Current smoking among gynecologic cancer survivors was driven by a 35.4% prevalence among cervical cancer survivors, compared with 21.9% for ovarian and 18.8% for uterine cancer survivors (data shown in text only). Heavy alcohol consumption was highest among lung/larynx/pharynx cancer survivors (6.8%), while moderate drinking was highest among prostate cancer survivors (22.2%). For physical activity, 15% of leukemia/lymphoma survivors and 14.8% of prostate cancer survivors reported meeting the guidelines compared with only 7.1% of lung/larynx/pharynx survivors. The percentage of those meeting the BMI guidelines ranged from 29.2% (prostate) to 39.3% (lung/larynx/pharynx). For sleep duration, the percentage meeting guidelines ranged from 50.2% (gynecologic) to 63.1% (prostate).

### Adjusted analysis

Using logistic regression (Table 5), we examined odds of meeting lifestyle guidelines by cancer history. In adjusted models (model 3) cancer survivors were 1.13 times more likely to be nonsmokers compared with those without a cancer history [OR, 1.13; 95% confidence interval (CI), 1.06–1.21], but were less likely to meet guidelines on moderate to heavy alcohol consumption than those with no cancer history (OR, 0.93; 95% CI, 0.88–0.99). Survivors had a 14% higher odds

of meeting the physical activity guidelines than those with no cancer history (OR, 1.14; 95% CI, 1.07–1.22) and were 7% more likely to maintain a healthy BMI (OR, 1.07; 95% CI, 1.01–1.12). We found no significant difference in meeting sleep guidelines by cancer history (OR, 1.01; 95% CI, 0.97–1.06).

We found statistically significant interaction by age for multiple lifestyle factors (Table 6): survivors age 18–<40 were 31% less likely to be nonsmokers than those age 18–<40 with no cancer history (95% CI, 0.55–0.87), while survivors age 40–<65 and 65+ had a 21% and 35% higher odds of reporting not smoking (95% CIs, 1.09–1.34 and 1.20–1.51, respectively,  $P_{\text{interaction}} < 0.001$ ) compared with those of the same age with no cancer history. Survivors age 18–<40 were more likely to refrain from moderate/heavy alcohol use (OR, 1.32; 95% CI, 1.02–1.71), but survivors age 65+ were 14% less likely to refrain from moderate/heavy alcohol use (95% CI, 0.79–0.94;  $P_{\text{interaction}} = 0.002$ ) compared with age-specific groups with no cancer history.  $P_{\text{interaction}}$  values were not significantly different by age for physical activity or maintaining healthy BMI. Cancer survivors age 18–<40 were less likely to meet sleep guidelines than those of the same age group with no cancer history (OR, 0.73; 95% CI, 0.60–0.89), while in older age groups there was no significant association between cancer history and meeting sleep guidelines ( $P_{\text{interaction}} < 0.001$ ).

**Table 2.** Cancer sites and years since diagnosis, by sex in the adult population in the NHIS (2013–2017).<sup>a</sup>

	No. of cases	%	SE	Average years since diagnosis
Women				
Breast	2,672	34.9	0.7	11.5
Cervix	834	10.2	0.4	18.6
Ovary	287	3.7	0.3	14.9
Colon	374	4.9	0.3	10.0
Uterus	559	7.2	0.3	16.9
Melanoma	525	7.0	0.3	10.9
Larynx, lung, pharynx	230	2.9	0.2	6.3
Leukemia, lymphoma	281	3.4	0.2	10.7
Multiple	810	10.7	0.4	13.2
Other	1,158	15.1	0.5	9.3
Men				
Prostate	1,709	34.2	0.8	8.2
Colon	369	7.2	0.4	9.6
Melanoma	489	10.3	0.5	9.2
Larynx, lung, pharynx	272	5.4	0.4	6.9
Leukemia, lymphoma	284	6.3	0.4	10.4
Multiple	564	11.3	0.5	9.6
Other	1,231	25.4	0.7	8.8

<sup>a</sup>All reported *N*s are unweighted and % are weighted.

## Discussion

Our observed prevalence rates suggest that there is an overall need to implement health promotion interventions, and that these interventions are particularly needed among cancer survivors who have higher health risks. Health promotion priorities also differ by age and cancer site. For instance, smoking rates were highest among younger individuals, and were particularly elevated among gynecologic cancer survivors, while older cancer survivors reported the lowest rates of meeting physical activity guidelines.

In adjusted analyses we observed that cancer survivors had a higher odds of meeting guidelines for smoking, physical activity, and BMI, but were less likely to meet guidelines for alcohol consumption, and were no different than those with no cancer history for sleep duration. Adjusted analyses by age suggested a higher odds of smoking and sleep in survivors age 18–<40, and moderate/heavy alcohol use among older survivors compared with those with no cancer history. Both prevalence estimates and regression analyses contribute to our understanding of public health priorities.

We also set out to compare our results with the 1998–2001 NHIS analyses to chart progress in the cancer survivor population over time (21). From the prior to the current time period, those with a cancer history who reported smoking declined from 20.2% to 14.1% ( $P < 0.001$ ). Similar to our findings, a publication of 2009 BRFSS data reported that 15% of cancer survivors were current cigarette smokers (19). While prevalence has declined and observed ORs suggest that cancer survivors are less likely to smoke than noncancer controls, public health efforts remain necessary to target smoking cessation both among patients with cancer, in particular among younger survivors, and those with gynecologic cancers (particularly cervical cancer survivors), who still had an alarmingly high smoking prevalence in this study (34, 35).

In contrast to the improvement seen in smoking prevalence among survivors, the percentage of moderate to heavy drinkers showed a statistically significant increase from 16.3% to 18.8% ( $P < 0.001$ ) from the prior to the current NHIS study, a trend that seemed to be driven by those age 40–<65 (increase 17.0% to 20.3%) and age 65+ (increase 15.2% to 18.0%). Alcohol consumption has negative health conse-

quences, not only in relation to breast cancer risk (10), but also for cancers of the oral cavity, larynx, and pharynx; esophageal squamous cell carcinoma; liver; and colon or rectum (10). There is also some evidence of increased risk of new primary cancers of these cancer sites with increased alcohol intake among those who have a cancer diagnosis (11). These observations led the IARC to classify alcohol as a group 1 carcinogen (36). A recent study of alcohol intake among cancer survivors in the NHIS found the highest rates of heavy drinking among ovarian (7.9%), melanoma (7.1%), and cervical cancer survivors (6.1%; ref. 37), suggesting that alcohol consumption may be a critical ongoing health behavior to target, particularly among those groups with higher consumption. Alcohol consumption was also the only health recommendation that cancer survivors were less likely to meet than those with no cancer history in logistic regression analyses.

In the 1998–2001 NHIS data, 29.6% of survivors met aerobic physical activity guidelines of 150 minutes of moderate-intensity or 60 minutes of vigorous-intensity activity weekly. When we combine the 14.2% in this study who met both strength and aerobic guidelines with the 24.2% who met aerobic physical activity guidelines (total 38.4%), it appears that a greater percentage of survivors meet aerobic guidelines at present ( $P < 0.001$ ). A previous study comparing the proportion of older adults meeting physical activity guidelines using the 2011–2012 National Health and Nutrition Examination Survey (NHANES), and 2013 NHIS and BRFSS data found that more people reported meeting the aerobic physical activity guidelines in BRFSS (44.3%), while 27.5% met guidelines in NHANES and 35.8% in NHIS (38). These differences in physical activity reporting by survey could be due to the survey technique (i.e., telephone vs. in-person) or timeframe of physical activity (i.e., prior 30 days vs. 1 year) but overall suggest results similar to ours. Despite significant improvements in prevalence of meeting guidelines since 2001, the 17.3% of cancer survivors who currently report insufficient activity and 39.2% who report no physical activity are critical target populations, as physical activity can mitigate many of the late and long-term side effects of diagnosis and treatment. Physical activity has also been associated with lower cancer (39) and mortality (40) risk in both the general population and in cancer survivors (41, 42). A recent roundtable convened by the American College of Sports Medicine led to publication of more

**Table 3.** Prevalence of health behaviors by cancer history among the adult population in the NHIS (2013–2017).<sup>a, b</sup>

Characteristic	History of cancer					No history of cancer					P <sup>c</sup>
	Total n	Total	Age in years			Total n	Total	Age in years			
			18-<40	40-<65	≥65			18-<40	40-<65	≥65	
		% (SE)	% (SE)	% (SE)	% (SE)		% (SE)	% (SE)	% (SE)	% (SE)	
Smoking status											<0.001
Current	1,847	14.0 (0.4)	31.0 (1.9)	21.1 (0.7)	7.8 (0.4)	25,116	16.7 (0.2)	17.6 (0.2)	19.3 (0.2)	9.6 (0.2)	
Former	4,715	37.7 (0.5)	12.8 (1.4)	30.3 (0.8)	45.0 (0.7)	32,184	21.7 (0.2)	12.5 (0.2)	22.8 (0.2)	36.7 (0.3)	
Never	6,007	47.7 (0.6)	55.3 (2.0)	48.1 (0.8)	46.5 (0.7)	90,102	61.3 (0.2)	69.5 (0.3)	57.5 (0.3)	53.3 (0.3)	
Smoking frequency <sup>d</sup>											
Every day	1,502	81.3 (1.1)	82.5 (2.7)	79.9 (1.6)	83.2 (1.9)	19,103	75.8 (0.4)	69.8 (0.6)	79.6 (0.5)	81.3 (0.8)	
Some days	345	18.7 (1.1)	17.5 (2.7)	20.1 (1.6)	16.8 (1.9)	6,013	24.2 (0.4)	30.2 (0.6)	20.4 (0.5)	18.7 (0.8)	
Alcohol drinking status											<0.001
Life-time abstainer	2,270	17.3 (0.4)	12.3 (1.4)	12.9 (0.6)	20.5 (0.6)	29,859	19.1 (0.2)	19.9 (0.3)	15.4 (0.2)	25.3 (0.4)	
Former	3,021	23.1 (0.4)	13.6 (1.5)	20.1 (0.7)	26.0 (0.6)	21,291	13.8 (0.2)	6.7 (0.1)	15.3 (0.2)	24.3 (0.3)	
Current infrequent	1,869	15.0 (0.4)	17.9 (1.6)	16.5 (0.7)	13.8 (0.5)	18,584	12.4 (0.1)	10.9 (0.2)	13.5 (0.2)	12.9 (0.2)	
Current light	3,005	24.5 (0.5)	36.4 (2.1)	29.0 (0.8)	20.4 (0.6)	44,873	31.4 (0.2)	36.7 (0.3)	31.7 (0.2)	20.5 (0.3)	
Current moderate	1,657	13.6 (0.4)	14.2 (1.5)	13.8 (0.7)	13.3 (0.5)	22,746	16.0 (0.1)	18.1 (0.2)	16.2 (0.2)	11.5 (0.2)	
Current heavy	633	5.0 (0.2)	3.7 (0.8)	6.2 (0.4)	4.4 (0.3)	8,024	5.5 (0.1)	5.9 (0.1)	6.0 (0.1)	3.9 (0.1)	
Alcohol drinking days/week <sup>d</sup>											<0.001
<1	3,441	48.0 (0.7)	59.6 (2.5)	48.3 (1.2)	46.0 (1.0)	44,287	46.2 (0.2)	46.4 (0.4)	45.8 (0.3)	46.7 (0.5)	
1–3	2,344	32.5 (0.7)	33.0 (2.4)	37.3 (1.1)	28.8 (0.9)	37,930	40.9 (0.2)	45.4 (0.3)	39.8 (0.3)	31.5 (0.4)	
4–6	489	6.9 (0.4)	3.8 (1.0)	6.5 (0.6)	7.7 (0.5)	5,729	6.1 (0.1)	5.4 (0.1)	6.6 (0.2)	6.9 (0.3)	
7	913	12.5 (0.5)	3.6 (0.8)	7.9 (0.6)	17.5 (0.7)	6,760	6.8 (0.1)	2.8 (0.1)	7.9 (0.2)	14.9 (0.4)	
Physical activity guidelines met											<0.001
Both strength and aerobic	1,718	14.2 (0.4)	22.0 (1.9)	17.0 (0.7)	11.6 (0.5)	29,708	21.1 (0.2)	28.6 (0.3)	19.0 (0.2)	11.1 (0.2)	
Aerobic only	3,053	24.2 (0.5)	30.3 (1.9)	26.3 (0.7)	22.2 (0.6)	41,436	27.8 (0.2)	29.8 (0.3)	28.0 (0.2)	23.9 (0.3)	
Strength only	656	5.2 (0.2)	3.6 (0.8)	3.9 (0.4)	6.2 (0.3)	5,895	4.1 (0.1)	3.5 (0.1)	4.0 (0.1)	5.2 (0.2)	
Insufficient	2,198	17.3 (0.4)	15.5 (1.6)	18.0 (0.7)	17.1 (0.5)	23,695	15.8 (0.1)	14.2 (0.2)	16.8 (0.2)	16.8 (0.3)	
No physical activity reported	5,023	39.2 (0.6)	28.5 (1.9)	34.9 (0.9)	42.9 (0.7)	47,234	31.2 (0.3)	23.9 (0.3)	32.3 (0.3)	43.0 (0.5)	
BMI											<0.001
Underweight	260	2.0 (0.2)	2.4 (0.6)	1.6 (0.2)	2.2 (0.2)	2,470	1.7 (0.0)	2.2 (0.1)	1.0 (0.0)	1.9 (0.1)	
Normal	3,812	30.5 (0.5)	35.9 (2.2)	27.9 (0.8)	31.4 (0.6)	48,424	33.4 (0.2)	40.7 (0.3)	27.2 (0.2)	32.1 (0.3)	
Overweight	4,272	33.8 (0.5)	27.5 (2.0)	30.9 (0.8)	36.2 (0.7)	48,922	33.0 (0.2)	29.7 (0.3)	34.7 (0.2)	35.7 (0.3)	
Obese class 1	2,365	18.5 (0.4)	14.9 (1.6)	19.5 (0.7)	18.4 (0.6)	25,550	17.0 (0.1)	14.0 (0.2)	19.5 (0.2)	17.3 (0.3)	
Obese class 2	1,513	11.7 (0.3)	15.5 (1.5)	15.9 (0.6)	8.7 (0.4)	17,152	11.3 (0.1)	10.4 (0.2)	13.3 (0.2)	9.0 (0.2)	
Hours of sleep											
<5	489	3.8 (0.2)	7.7 (1.1)	4.9 (0.4)	2.8 (0.2)	4,284	2.9 (0.1)	2.4 (0.1)	3.4 (0.1)	2.7 (0.1)	
5–<7	3,263	25.9 (0.4)	37.1 (2.1)	31.3 (0.8)	21.4 (0.5)	41,768	28.3 (0.2)	28.6 (0.2)	30.9 (0.2)	22.3 (0.3)	
7–8	6,876	54.5 (0.5)	44.4 (2.1)	52.4 (0.9)	56.9 (0.6)	85,766	58.0 (0.2)	59.5 (0.3)	56.8 (0.2)	57.8 (0.4)	
>8–9	715	5.6 (0.2)	4.1 (0.9)	4.1 (0.3)	6.6 (0.3)	6,103	4.0 (0.1)	3.8 (0.1)	2.9 (0.1)	6.7 (0.2)	
>9	872	6.5 (0.3)	3.4 (0.8)	4.1 (0.3)	8.3 (0.4)	5,418	3.5 (0.1)	2.6 (0.1)	2.6 (0.1)	6.9 (0.2)	

<sup>a</sup>All reported *N*s are unweighted and % are weighted.

<sup>b</sup>Percentages may not add up to 100 due to rounding or missing data.

<sup>c</sup>*P* values in the table are comparing those with a history of cancer to those without a history of cancer overall.

<sup>d</sup>Smoking and drinking frequency are described only for those who reported those behaviors at the time of questionnaire.

targeted physical activity goals by cancer site, suggesting that even with functional limitations, avoiding inactivity where possible yields some health benefits (13). Exercise programs for cancer survivors may have to accommodate issues such as lymphedema, ostomy, neuropathy, or fatigue, but these considerations do not contraindicate exercise (13).

In the previous NHIS study, 21.9% of cancer survivors reported obesity, whereas in our analysis 30.2% of survivors reported obesity (*P* < 0.001). These findings are in concordance with other population-based studies that have shown rising trends in obesity prevalence in the cancer survivor population (43).

A previous registry-based survey of *n* = 1,171 cancer survivors reported longer sleep duration among male but not female breast cancer survivors (44). Various studies have also shown associations between sleep disruption among cancer survivors and detrimental

health consequences for cardiometabolic and immune system health, neurobehavioral function, depression, fatigue, and quality of life (45–48). Studies in the general population have further demonstrated an association between both short and long sleep duration (vs. average) and higher mortality risk (49). Our findings that sleep duration differed by age among those with a history of cancer (higher prevalence of long sleep duration among the older population and short sleep duration among those age 18–<40) should be further investigated. Future studies may also collect data on sleep quality in addition to duration. In addition, known effective interventions such as cognitive behavioral therapy for insomnia should be more widely available to survivors (7).

Strengths of our study include the nationally representative non-institutionalized sample and multiple years of data. We were able to

**Table 4.** Adherence to lifestyle recommendations by cancer site among the adult population in the NHIS (2013–2017).<sup>a</sup>

	Breast		Prostate		Lung, larynx, pharynx		Gynecologic		Colorectal		Leukemia/lymphoma	
	n	% (SE)	n	% (SE)	n	% (SE)	n	% (SE)	n	% (SE)	n	% (SE)
Current smoker												
Yes	297	9.2 (0.6)	190	10.0 (0.8)	149	18.6 (1.8)	542	26.2 (1.1)	130	10.9 (1.0)	92	11.8 (1.3)
No	2,797	90.8 (0.6)	17,77	90.0 (0.8)	594	81.4 (1.8)	1,483	73.8 (1.1)	954	89.1 (1.0)	640	88.2 (1.3)
Alcohol use												
Life-time abstainer	746	23.4 (0.9)	235	11.1 (0.8)	121	16.1 (1.5)	355	17.7 (1.0)	232	21.4 (1.4)	138	18.7 (1.7)
Former	700	21.9 (0.9)	515	25.9 (1.2)	246	32.8 (2.1)	482	24.0 (1.1)	311	28.2 (1.6)	168	22.3 (1.8)
Current infrequent	480	16.3 (0.8)	219	11.5 (0.9)	120	17.1 (1.7)	389	20.1 (1.1)	145	12.7 (1.2)	105	13.9 (1.5)
Current light	706	23.8 (0.9)	472	24.5 (1.1)	125	16.5 (1.6)	518	25.2 (1.2)	210	20.4 (1.5)	184	26.1 (1.9)
Current moderate	280	9.5 (0.6)	418	22.2 (1.1)	74	10.7 (1.3)	151	7.7 (0.8)	131	12.7 (1.2)	95	13.3 (1.5)
Current heavy	160	5.2 (0.5)	94	4.8 (0.6)	49	6.8 (1.1)	108	5.3 (0.6)	47	4.6 (0.8)	34	5.7 (1.1)
Meets physical activity guidelines												
Yes	406	13.9 (0.8)	282	14.8 (0.9)	60	7.1 (1.1)	255	13.5 (1.0)	108	10.9 (1.1)	99	15.0 (1.6)
No	2,710	86.1 (0.8)	1,697	85.2 (0.9)	687	92.9 (1.1)	1,778	86.5 (1.0)	981	89.1 (1.1)	637	85.0 (1.6)
Maintains a healthy BMI												
Yes	1,025	35.0 (1.1)	552	29.2 (1.2)	286	39.3 (2.2)	577	29.1 (1.3)	289	29.6 (1.8)	233	33.7 (2.0)
No	1,949	65.0 (1.1)	1,402	70.8 (1.2)	443	60.7 (2.2)	1,355	70.9 (1.3)	769	70.4 (1.8)	486	66.3 (2.0)
Meets sleep guidelines												
Yes	1,818	61.1 (1.1)	1,192	63.1 (1.3)	377	53.7 (2.1)	995	50.2 (1.3)	567	53.9 (1.8)	428	59.6 (2.2)
No	1,186	38.9 (1.1)	723	36.9 (1.3)	337	46.3 (2.1)	970	49.8 (1.3)	483	46.1 (1.8)	287	40.4 (2.2)

<sup>a</sup>All reported Ns are unweighted and % are weighted.

examine multiple health behaviors and demonstrate differences in prevalence by age and cancer site, providing targets for behavioral interventions to improve lifestyle. Still, there are limitations inherent to the NHIS data. All NHIS data are self-reported, which may lead to social desirability bias in reporting or misclassification of cancer diagnosis or outcome. In addition, we were unable to look at variables such as cancer treatment or diet (not included in surveys), current cancer status, or screening behaviors, as the 2014–2017 surveys only had questions on screening behaviors in the prior year (which could not be interpreted in light of current screening recommendations;

ref. 50). The cross-sectional design also precludes looking at changes in health behaviors over time within individuals. We were further unable to examine prediagnosis behaviors or temporality of associations between health behaviors and cancer. NHIS also cannot generalize to those who are in nursing homes or other care facilities.

Research continues to show that meeting guidelines on smoking, physical activity, body weight, and alcohol consumption has numerous health benefits, particularly for a high-risk population like cancer survivors. Emerging research also suggests that sleep may be a key health target for survivors. The challenge is disseminating and

**Table 5.** ORs and 95% CIs for adherence to lifestyle recommendations for cancer survivors compared with those without a history of cancer among the adult population in the NHIS (2013–2017).

	Model 1 <sup>a</sup> OR (95% CI)	Model 2 <sup>b</sup> OR (95% CI)	Model 3 <sup>c</sup> OR (95% CI)
Nonsmoker			
No cancer history	1.00	1.00	1.00
Cancer survivor	0.95 (0.89–1.02)	1.12 (1.05–1.20)	1.13 (1.06–1.21)
No moderate/heavy alcohol use			
No cancer history	1.00	1.00	1.00
Cancer survivor	0.92 (0.87–0.98)	0.93 (0.88–0.99)	0.93 (0.88–0.99)
Meets physical activity guidelines			
No cancer history	1.00	1.00	1.00
Cancer survivor	0.89 (0.84–0.94)	1.16 (1.09–1.24)	1.14 (1.07–1.22)
Maintains a healthy BMI			
No cancer history	1.00	1.00	1.00
Cancer survivor	0.93 (0.88–0.98)	1.06 (1.00–1.11)	1.07 (1.01–1.12)
Meets sleep guidelines			
No cancer history	1.00	1.00	1.00
Cancer survivor	0.87 (0.83–0.91)	1.02 (0.97–1.06)	1.01 (0.98–1.08)

<sup>a</sup>Model 1 is adjusted for age, sex, and race/ethnicity.

<sup>b</sup>Model 2 is adjusted for all model 1 factors, as well as education, insurance status, functional limitations, and health status.

<sup>c</sup>Model 3 is adjusted for all model 2 factors, as well as for meeting all other guidelines (smoking, physical activity, alcohol, BMI, and sleep).

**Table 6.** ORs and 95% CIs for adherence to lifestyle recommendations for cancer survivors compared with those without a history of cancer among the adult population in the NHIS (2013–2017), stratified by age.

Odds of meeting lifestyle guidelines	OR (95% CI) <sup>a</sup>	<i>P</i> <sub>interaction</sub> <sup>b</sup>
Nonsmoker		<0.001
18–39 years	0.69 (0.55–0.87)	
40–64 years	1.21 (1.09–1.34)	
65+ years	1.35 (1.20–1.51)	
No moderate/heavy alcohol use		0.022
18–39 years	1.32 (1.02–1.71)	
40–64 years	0.96 (0.87–1.07)	
65+ years	0.86 (0.79–0.94)	
Meets physical activity guidelines		0.575
18–39 years	1.04 (0.82–1.32)	
40–64 years	1.18 (1.06–1.31)	
65+ years	1.18 (1.07–1.30)	
Maintains a healthy BMI		0.092
18–39 years	0.93 (0.75–1.16)	
40–64 years	1.16 (1.06–1.28)	
65+ years	1.02 (0.95–1.10)	
Meets sleep guidelines		<0.001
18–39 years	0.73 (0.60–0.89)	
40–64 years	1.07 (0.99–1.16)	
65+ years	1.02 (0.96–1.09)	

<sup>a</sup>ORs are adjusted for age, sex, race/ethnicity, education, insurance status, functional limitations, and health status, as well as for meeting all other guidelines (smoking, physical activity, alcohol, BMI, and sleep).

<sup>b</sup>Wald test was used to generate *P* values for interaction.

delivering effective programs and services more broadly and encouraging healthcare providers to counsel cancer survivors about the need for a healthy lifestyle during and after cancer (51, 52). Comparing our findings to those published 15 years ago, there has been some degree of success in reducing smoking rates, but specific groups still

## References

- Bluthmann SM, Mariotto AB, Rowland JH. Anticipating the “silver tsunami”: prevalence trajectories and comorbidity burden among older cancer survivors in the United States. *Cancer Epidemiol Biomarkers Prev* 2016;25:1029–36.
- American Cancer Society. Cancer treatment and survivorship facts and figures 2019–2021: American Cancer Society; 2019. Available from: <https://www.cancer.org/research/cancer-facts-statistics/survivor-facts-figures.html>.
- Harrington CB, Hansen JA, Moskowitz M, Todd BL, Feuerstein M. It's not over when it's over: long-term symptoms in cancer survivors—a systematic review. *Int J Psychiatry Med* 2010;40:163–81.
- Rowland JH, Gallicchio L, Mollica M, Saiontz N, Falisi AL, Tesaro G. Survivorship science at the NIH: lessons learned from grants funded in fiscal year 2016. *J Natl Cancer Inst* 2019;111:109–17.
- Harrop JP, Dean JA, Paskett ED. Cancer survivorship research: a review of the literature and summary of current NCI-designated cancer center projects. *Cancer Epidemiol Biomarkers Prev* 2011;20:2042–47.
- Song M, Giovannucci E. Preventable incidence and mortality of carcinoma associated with lifestyle factors among white adults in the United States. *JAMA Oncol* 2016;2:1154–61.
- Denlinger CS, Sanft T, Baker KS, Broderick G, Demark-Wahnefried W, Friedman DL, et al. Survivorship, version 2.2018, NCCN clinical practice guidelines in oncology. *J Natl Compr Canc Netw* 2018;16:1216–47.
- Cancer.Net. Healthy living after cancer; 2018. Available from: <https://www.cancer.net/survivorship/healthy-living/healthy-living-after-cancer>.
- Cancer.Net. Stopping tobacco use after a cancer diagnosis; 2019. Available from: <https://www.cancer.net/navigating-cancer-care/prevention-and-healthy-living/stopping-tobacco-use-after-cancer-diagnosis>
- LoConte NK, Brewster AM, Kaur JS, Merrill JK, Alberg AJ. Alcohol and cancer: a statement of the American Society of Clinical Oncology. *J Clin Oncol* 2018;36:83–93.
- Rock CL, Doyle C, Demark-Wahnefried W, Meyerhardt J, Courneya KS, Schwartz AL, et al. Nutrition and physical activity guidelines for cancer survivors. *CA Cancer J Clin* 2012;62:243–74.
- World Cancer Research Fund International/American Institute for Cancer Research. Diet, nutrition, physical activity and cancer: a Global Perspective Continuous Update Project Expert Report [Internet]. 2018. Available from: <https://www.wcrf.org/dietandcancer>.
- Campbell KL, Winters-Stone KM, Wiskemann J, May AM, Schwartz AL, Courneya KS, et al. Exercise guidelines for cancer survivors: consensus statement from International Multidisciplinary Roundtable. *Med Sci Sports Exerc* 2019;51:2375–90.
- National Comprehensive Cancer Network. Survivorship: National Comprehensive Cancer Network; 2019. Available from: [https://www.nccn.org/professionals/physician\\_gls/pdf/survivorship.pdf](https://www.nccn.org/professionals/physician_gls/pdf/survivorship.pdf).
- Roscoe JA, Kaufman ME, Matteson-Rusby SE, Palesh OG, Ryan JL, Kohli S, et al. Cancer-related fatigue and sleep disorders. *Oncologist* 2007;12:35–42.
- Gallicchio L, Kalesan B. Sleep duration and mortality: a systematic review and meta-analysis. *J Sleep Res* 2009;18:148–58.
- Alfano CM, Lichstein KL, Vander Wal GS, Smith AW, Reeve BB, McTiernan A, et al. Sleep duration change across breast cancer survivorship: associations with symptoms and health-related quality of life. *Breast Cancer Res Treat* 2011;130:243–54.

have alarmingly high smoking rates. Our data also suggest insufficient progress with regards to meeting physical activity guidelines and reducing moderate to heavy alcohol consumption. Research, advocacy, and policy may each be needed to further affect prevalence of these risk behaviors. Health researchers, oncologists, and other health care providers may utilize the data presented here to prioritize health behavior change in the cancer survivor and general population, with the goal of improving quality of life and multiple health outcomes.

## Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

## Authors' Contributions

**Conception and design:** H. Arem, S.K. Mama, J.H. Rowland, K.M. Bellizzi  
**Development of methodology:** H. Arem, S.K. Mama, J.H. Rowland, K.M. Bellizzi  
**Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.):** H. Arem, S.K. Mama  
**Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis):** H. Arem, S.K. Mama, X. Duan, J.H. Rowland, K.M. Bellizzi, D.K. Ehlers  
**Writing, review, and/or revision of the manuscript:** H. Arem, S.K. Mama, J.H. Rowland, K.M. Bellizzi, D.K. Ehlers  
**Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases):** H. Arem, D.K. Ehlers  
**Study supervision:** H. Arem

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18. Demark-Wahnefried W, Aziz NM, Rowland JH, Pinto BM. Riding the crest of the teachable moment: promoting long-term health after the diagnosis of cancer. *J Clin Oncol* 2005;23:5814–30.
19. Underwood JM, Townsend JS, Stewart SL, Buchanan N, Ekwueme DU, Hawkins NA, et al. Surveillance of demographic characteristics and health behaviors among adult cancer survivors—Behavioral Risk Factor Surveillance System, United States, 2009. *MMWR Surveill Summ* 2012;61:1–23.
20. Blanchard CM, Courneya KS, Stein K. Cancer survivors' adherence to lifestyle behavior recommendations and associations with health-related quality of life: results from the American Cancer Society's SCS-II. *J Clin Oncol* 2008;26:2198–204.
21. Bellizzi KM, Rowland JH, Jeffery DD, McNeel T. Health behaviors of cancer survivors: examining opportunities for cancer control intervention. *J Clin Oncol* 2005;23:8884–93.
22. Wilson LM, Avila Tang E, Chander G, Hutton HE, Odelola OA, Elf JL, et al. Impact of tobacco control interventions on smoking initiation, cessation, and prevalence: a systematic review. *J Environ Public Health* 2012;2012:961724.
23. Alfano CM, Bluethmann SM, Tesaro G, Perna F, Agurs-Collins T, Elena JW, et al. NCI funding trends and priorities in physical activity and energy balance research among cancer survivors. *J Natl Cancer Inst* 2015;108. pii: djv285.
24. Centers for Disease Control and Prevention. National health interview survey methods: National Center for Health Statistics, Centers for Disease Control and Prevention; 2019. Available from: <https://www.cdc.gov/nchs/nhis/methods.htm>.
25. Centers for Disease Control and Prevention. Glossary – alcohol; 2018. Available from: [https://www.cdc.gov/nchs/nhis/alcohol/alcohol\\_glossary.htm](https://www.cdc.gov/nchs/nhis/alcohol/alcohol_glossary.htm).
26. Bagnardi V, Rota M, Botteri E, Tramacere I, Islami F, Fedirko V, et al. Alcohol consumption and site-specific cancer risk: a comprehensive dose–response meta-analysis. *Br J Cancer* 2015;112:580–93.
27. Connor J. Alcohol consumption as a cause of cancer. *Addiction* 2017;112:222–8.
28. Cao Y, Willett WC, Rimm EB, Stampfer MJ, Giovannucci EL. Light to moderate intake of alcohol, drinking patterns, and risk of cancer: results from two prospective US cohort studies. *BMJ* 2015;351:h4238.
29. U.S. Department of Health and Human Services. Physical activity guidelines for Americans; 2008. Available from: <https://health.gov/paguidelines/guidelines/>.
30. Schmitz KH, Courneya KS, Matthews C, Demark-Wahnefried W, Galvão DA, Pinto BM, et al. American College of Sports Medicine roundtable on exercise guidelines for cancer survivors. *Med Sci Sports Exerc* 2010;42:1409–26.
31. Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, et al. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. *Sleep Health* 2015;1:40–3.
32. Parsons VL, Moriarity CL, Jonas K, Moore TF, Davis KE, Tompkins L. Design and estimation for the national health interview survey, 2006–2015. *Vital Health Stat* 2 2014;(165):1–53.
33. Centers for Disease Control and Prevention. Variance Estimation Guidance, NHIS 2016–2017; 2018. Available from: <https://www.cdc.gov/nchs/data/nhis/2016var.pdf>.
34. Warren GW, Kasza KA, Reid ME, Cummings KM, Marshall JR. Smoking at diagnosis and survival in cancer patients. *Int J Cancer* 2013;132:401–10.
35. International Agency for Research on Cancer. Tobacco smoking. IARC monographs on the evaluation of carcinogenic risks to humans [Internet]. 2018. Available from: <https://monographs.iarc.fr/wp-content/uploads/2018/06/mono100E-6.pdf>.
36. International Agency for Research on Cancer. Consumption of alcoholic beverages. IARC monographs on the evaluation of carcinogenic risks to humans [Internet]. 2018. Available from: <https://monographs.iarc.fr/wp-content/uploads/2018/06/mono100E-11.pdf>.
37. Lin H-Y, Fisher P, Harris D, Tseng TS. Alcohol intake patterns for cancer and non-cancer individuals: a population study. *Transl Cancer Res* 2019;8:S334–45.
38. Keadle SK, McKinnon R, Graubard BI, Troiano RP. Prevalence and trends in physical activity among older adults in the United States: a comparison across three national surveys. *Prev Med* 2016;89:37–43.
39. Moore SC, Lee I-M, Weiderpass E, Campbell PT, Sampson JN, Kitahara CM, et al. Association of leisure-time physical activity with risk of 26 types of cancer in 1.44 million adults. *JAMA Intern Med* 2016;176:816–25.
40. Moore SC, Patel AV, Matthews CE, Berrington de Gonzalez A, Park Y, Katki HA, et al. Leisure time physical activity of moderate to vigorous intensity and mortality: a large pooled cohort analysis. *PLoS Med* 2012;9:e1001335.
41. Ballard-Barbash R, Friedenreich CM, Courneya KS, Siddiqi SM, McTiernan A, Alfano CM. Physical activity, biomarkers, and disease outcomes in cancer survivors: a systematic review. *J Natl Cancer Inst* 2012;104:815–40.
42. Grimmett C, Corbett T, Brunet J, Shepherd J, Pinto BM, May CR, et al. Systematic review and meta-analysis of maintenance of physical activity behaviour change in cancer survivors. *Int J Behav Nutr Phys Act* 2019;16:37.
43. Greenlee H, Shi Z, Molmenti CLS, Rundel A, Tsai WY. Trends in obesity prevalence in adults with a history of cancer: results from the US National Health Interview Survey, 1997 to 2014. *J Clin Oncol* 2016;34:3133–40.
44. Forsythe LP, Helzlsouer KJ, MacDonald R, Gallicchio L. Daytime sleepiness and sleep duration in long-term cancer survivors and non-cancer controls: results from a registry-based survey study. *Support Care Cancer* 2012;20:2425–32.
45. Morin CM, Vallières A, Guay B, Ivers H, Savard J, Mérette C, et al. Cognitive behavioral therapy, singly and combined with medication, for persistent insomnia: a randomized controlled trial. *JAMA* 2009;301:2005–15.
46. Savard J, Morin CM. Insomnia in the context of cancer: a review of a neglected problem. *J Clin Oncol* 2001;19:895–908.
47. Hsu CY, Chen YT, Chen MH, Huang CC, Chiang CH, Huang PH, et al. The association between insomnia and increased future cardiovascular events: a nationwide population-based study. *Psychosom Med* 2015;77:743–51.
48. Hall MH, Smagula SF, Boudreau RM, Ayonayon HN, Goldman SE, Harris TB, et al. Association between sleep duration and mortality is mediated by markers of inflammation and health in older adults: the health, aging and body composition study. *Sleep* 2015;38:189.
49. Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Sleep duration and all-cause mortality: a systematic review and meta-analysis of prospective studies. *Sleep* 2010;33:585–92.
50. U.S. Preventive Services Task Force. USPSTF A and B Recommendations; 2019. Available from: <https://www.uspreventiveservicestaskforce.org/Page/Name/uspstf-a-and-b-recommendations/>.
51. Hardcastle SJ, Kane R, Chivers P, Hince D, Dean A, Higgs D, et al. Knowledge, attitudes, and practice of oncologists and oncology health care providers in promoting physical activity to cancer survivors: an international survey. *Support Care Cancer* 2018;26:3711–9.
52. Ligibel JA, Jones LW, Brewster AM, Clinton SK, Korde LA, Oeffinger KC, et al. Oncologists' attitudes and practice of addressing diet, physical activity, and weight management with patients with cancer: findings of an ASCO Survey of the Oncology Workforce. *J Oncol Pract* 2019;15:e520–8.